Inst. Manual

Subject	PV Module Installation Manual
Applicable Process	PV System Installation
Applicable Products	MF,MG series PV Module Products

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HYUNDAI
HEAVY INDUSTRIES CO.,LTD.

PV Module Production Dep't.

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1. Introduction

This manual contains information regarding the installation and the safe handling method of the photovoltaic module (hereafter referred to as “module”) supplied by Hyundai Heavy Industries Co., Ltd. (hereafter referred to as “HHI”). Installers should read and understand this guide before installing the module. The installer should conform to every safety precautions specified in this guide and local codes when installing a module. Before installing a solar photovoltaic system, mechanical and electrical requirements for the total system should be checked as well. Keep this guide in a safe place for future reference (care and maintenance).

2. General Information

This manual provides the installation information for HHI modules.
Each module has its own serial number.

Serial number : YYMMDD-XX-MxxxMG-0001(~9999) (Ex. 110317-21-M235MG-0001)

- YYMMDD : Production date
- XX : Production line
- MxxxMG : Model (xxx : output range)
- 0001(~9999) : Production number

1.1 Disclaim of Liability

The information in this manual is based on HHI’s knowledge and experience and is believed to be reliable; but any information including product specification (without limitations) and descriptions do not constitute over a warranty. HHI reserves the rights for any change the technical specification including the PV production, the specifications, or the product information sheets without prior notice.

HHI does not have any responsibility and the liability for loss, damage, or expense if the installer does not follow this guidance.

1.2 NOTICE

Installing solar photovoltaic systems requires specialized skills and knowledge, and should only be performed by qualified persons. Each module has a junction box for permanent cable connection. HHI can provide customers with fitted cables for easy installation. Installers should secure the safe installation status including all electrical hazards.

PID(Potential Induced Degradation)

· PID is not covered by Hyundai Limited Warranty for PV Modules.

· To prevent the PID phenomena, it is recommended to design the system to avoid PID or use the PID-free products.

Corrosion

· All the junctions on the conductive connection must be fixed. Metal containing iron in the conductive connection should be made with stainless steel or be treated against corrosion by anodizing, spray-painting, or galvanization to prevent rusting and corrosion.

1.3 DANGER

· Installers should secure the installation status, without limitation, including the risk of electric shock.

· Back sheet of PV module should be kept safe from any damage or scratch to prevent mechanical or electric shock.

· Do not stand or walk on module.

· Do not disassemble or remove any part of a PV module or such actions may cause electric shock, fire or damage.

· Keep safety regulations for all components used in the system, including wiring and cables, connectors, charging regulators, inverters, storage batteries and rechargeable batteries, etc.

1.4 WARNING

· Before installation, prevent the module from exposure to direct sunlight (If modules are exposed directly to sunlight without connection, each module generates over DC 30V, which is potentially hazardous.)

· Be sure to have more than two persons with anti-slip gloves on carry each PV module. Do not drop PV modules.

· All installation equipments and PV modules must be kept in dry condition during installation.

· Check the current and the voltage before connecting the line. There is potential hazard in case of higher current in series connection and higher voltage in parallel connection.

· All PV modules must be earthed by using earth device.

· Safety check for all other parts of systems should be finished before installation to prevent any electric hazard.

· Do not leave modules in places where flammable gases can be generated or collected.

· Do not wear metallic rings, watchbands, ear, nose, lip rings or other metallic devices while installing photovoltaic systems

· Do not leave un-fixed and unsafe PV modules unattended

· Do not use any damaged PV module, where it may cause fire, electric shock or injury.

· Do not focus light on a PV module, where it may cause fire and damage.

· Do not touch the terminals of junction box, in order to prevent electric shock and injury

· Do not re-arrange bypass diodes, where it may cause electric shock and injury.

· Do not use mirrors or other magnifiers to artificially concentrate sunlight on the modules.

· Do not disconnect the cable when the load to module is engaged.

· Check applied Class for module after installing the module.

· Do not remove any labels.

1.5 ⚠ CAUTION

· In order to prevent any performance drop, damage, or incapability, do not use paint and adhesive material to the module surface.

2. General Safety

The following requirements should be kept during installation and inspection.

· Check the inspection requirements by authorized personnel.

· All PV module system must be earthed. When installing the system, abide by all local, regional and national statutory regulations.

· System designer and installers should secure safe installation of PV modules. All installation must be conformed to all fire safety regulations. Additional structures can be applied for installation. If additional equipment is applied, it is necessary to check the fuse status, earth error and system isolation.

· Do not use different types of PV module in a same module array.

· Abide by the safety regulations for all other components within the total system.

3. Installation

3.1 General

· Before installing and operating HHI PV system, installer and operator should follow the requirements specified in this manual.

· Do not drill additional holes in the frame of the modules. This additional hole will void the warranty. Refer to the mounting profile in Picture1, Picture2.

· Appropriate materials should be used for mounting structure in order to prevent the module frame, mounting structure from corrosion.

· Secure the module using mounting holes provided and ¼ inch(6mm), stainless corrosion resistant material. Locking washers should be used for long-term security.

· Installation materials must be resisted against any corrosion of module frame, installation structures.

· When installing the system, it is necessary to avoid any shade caused by buildings or trees nearby.

· For more information about the installation, please contact an authorized personnel of HHI.

3.2 Notes on Installation

· Space between PV module frames and installation objects is necessary for cooling air circulation. Do not seal this space.

· Minimum 4 inch (10.14cm) of standoff height is necessary based on UL Fire Class C.

· The minimum distance between two fixed modules for linear thermal expansion of the module frame supports should be 5mm. Nevertheless, the recommended distance between two modules is 20 mm to allow wind circulation, in order to reduce pressure loads and improve module ventilation.

· The minimum distance between a module frame and a sidewall of clamp for linear thermal expansion of the module frame supports should be 2.5mm, in order to reduce pressure loads.

3.3 General Operation Condition

PV modules will be operated under General Operation Condition (GOC). Do not install PV module at site beyond General Operation Conditions or under specific condition.

1. General Operation Conditions

The site condition for the sea level and wind load should be matched the following requirements.

(1) Sea level of site : Below 1,000m (3,280 ft)

(2) Wind strength

· Below 5,400 Pa (5,400N/m^2, 550kg/m^2, 112 lb/ft^2) on the front module surface

· Below 2,400 Pa (2,400N/m^2, 225kg/m^2, 46 lb/ft^2) on the back module surface

※ If the wind strength is not over than 2,400 Pa (2,400N/m^2, 225kg/m^2, 46 lb/ft^2), the installation site over 1,000 m (3,280 ft) above sea level is permitted.

※ Installations under the condition of wind strength specified above are allowed only when the methods of installations comply with Module Installation Instruction (Appendix 1.)

2. Specific Site Condition

(1) Actual site condition should be checked for adequate installations.

1) Chloride is an important factor to be considered.

2) Hail, heavy snow, and sand are important factors to be considered.

3) Air pollution, chemical gas, acid rain, and smoke are important factors to be considered.

(2) Environmental conditions.(Corrosion warning)

1) PV modules shall not be installed in salty area within 500 m from a body of salt water and/or area where salty wind hit directly.

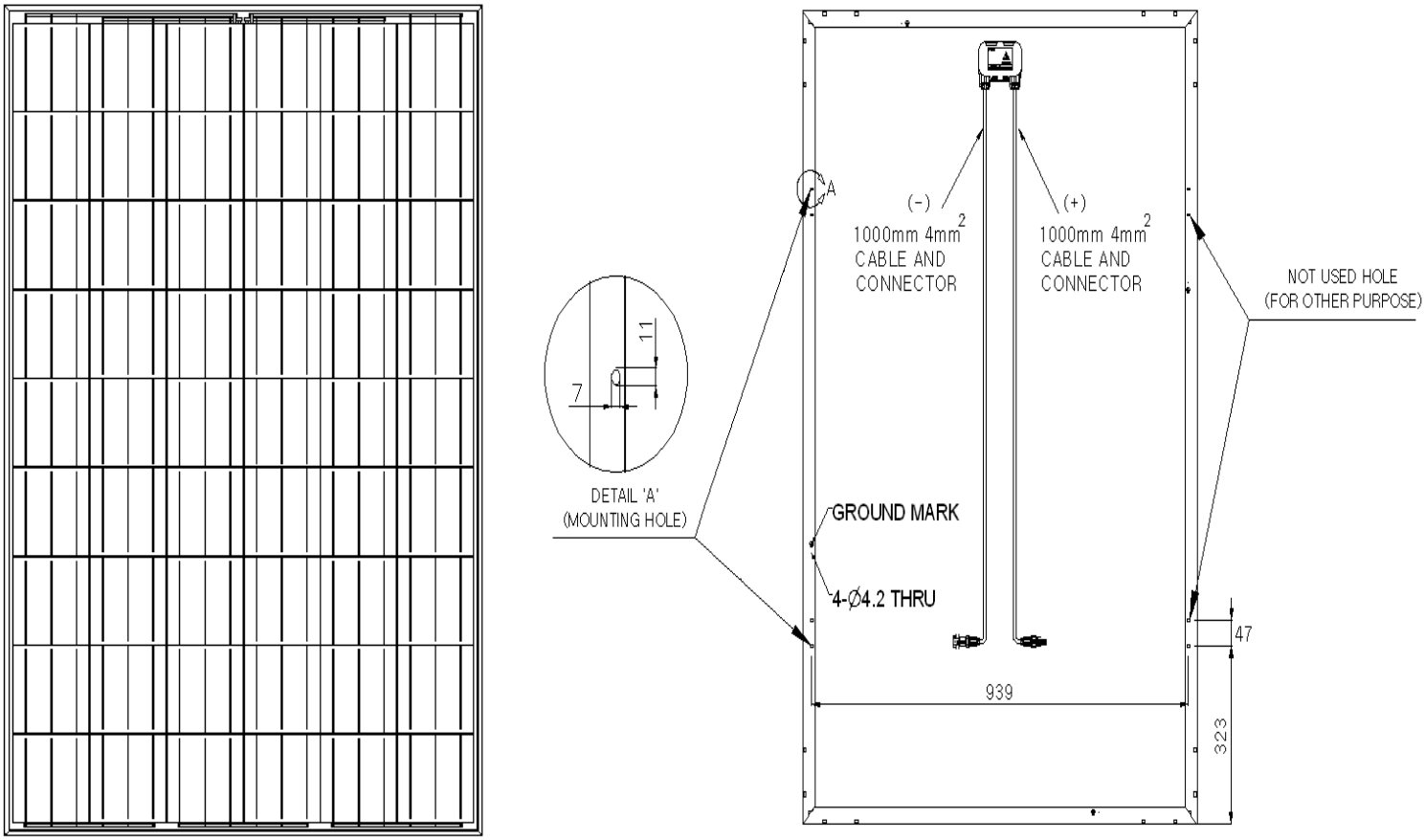
※ HYUNDAI modules have passed the IEC61701 test (Salt Mist Corrosion Test)

2) PV modules shall not be installed in sulfurous area near sulfurous volcano and sulfurous spring.

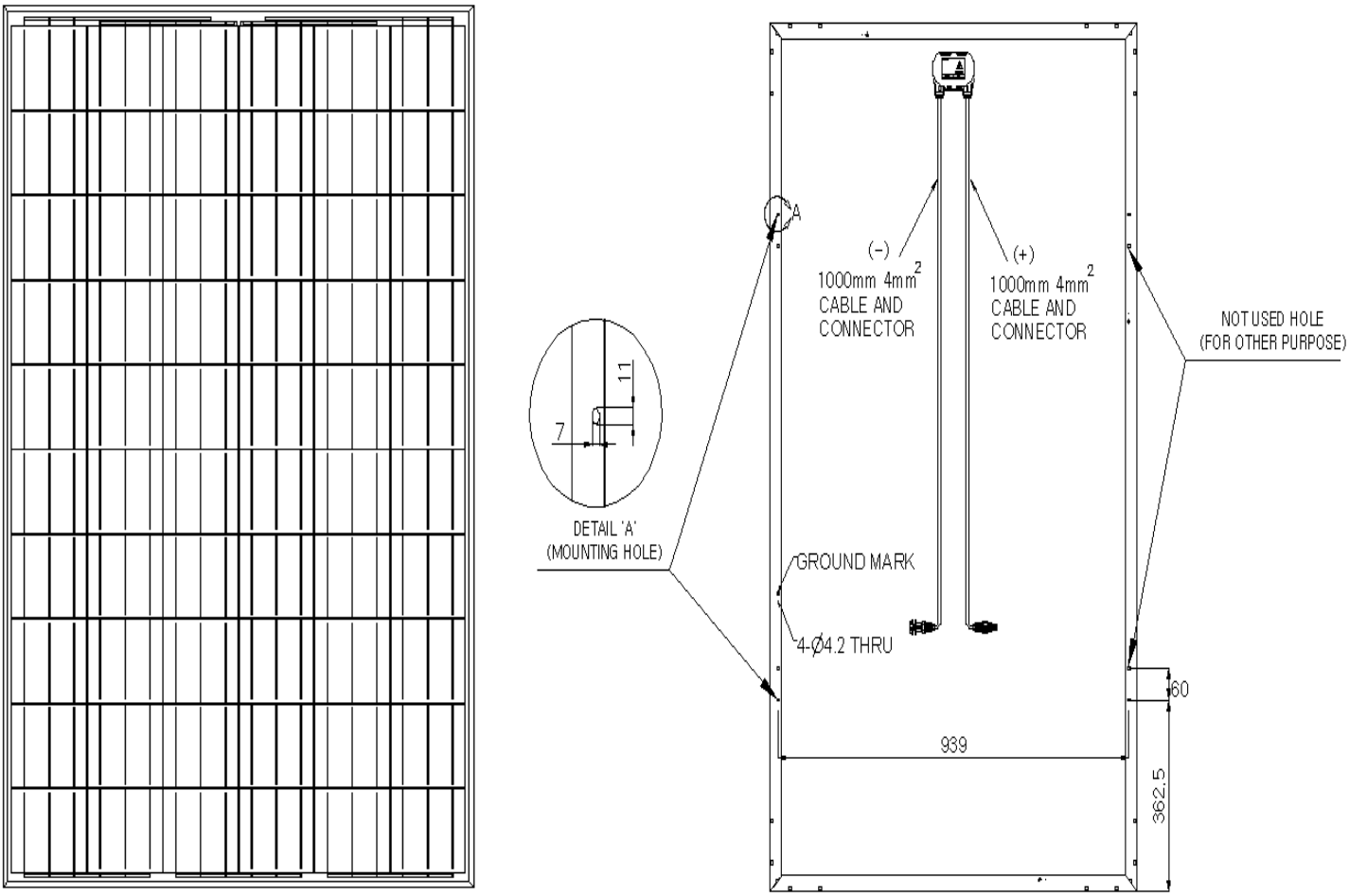
3.4 Mounting Method

All modules are fixed using mounting holes of long frame. Installers can apply additional support to prevent module from sliding at the short frame. It is not recommended to apply fixing methods using short frame, which can not fully cover the length of the module.

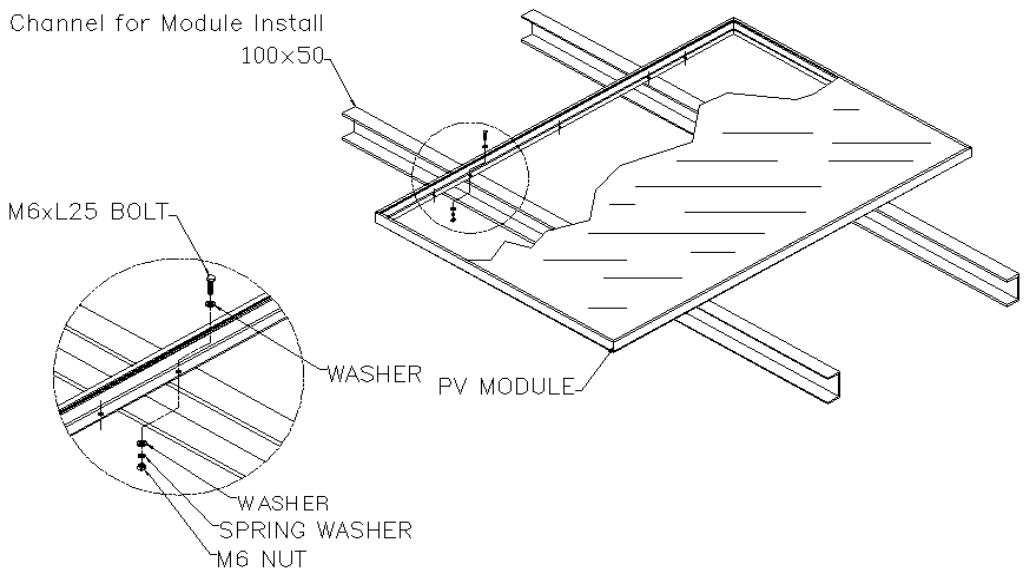
Detailed mounting method is described in 'module installation instruction' in the appendix.



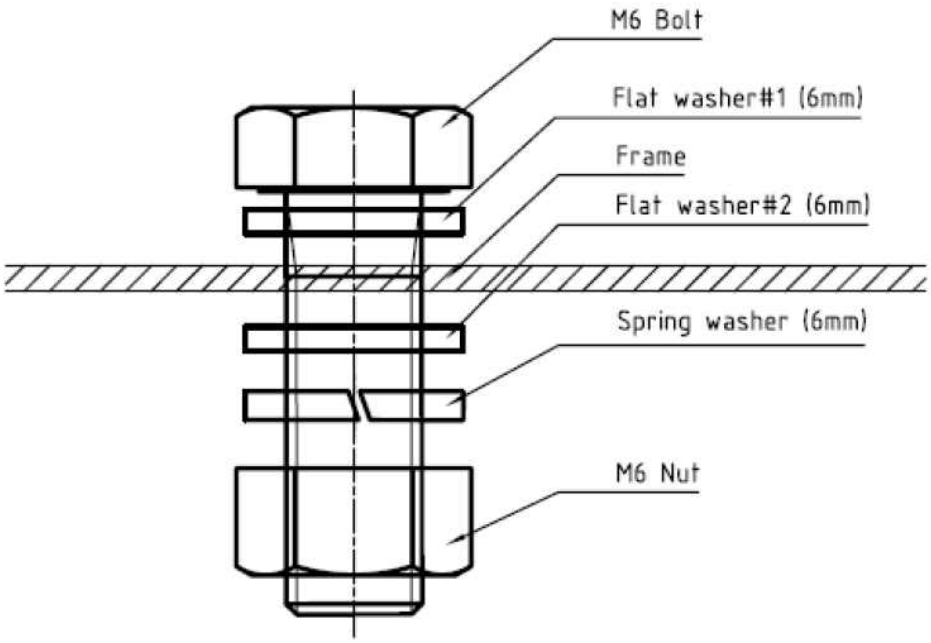
Picture 1. HiS-MxxxMF Hole Position



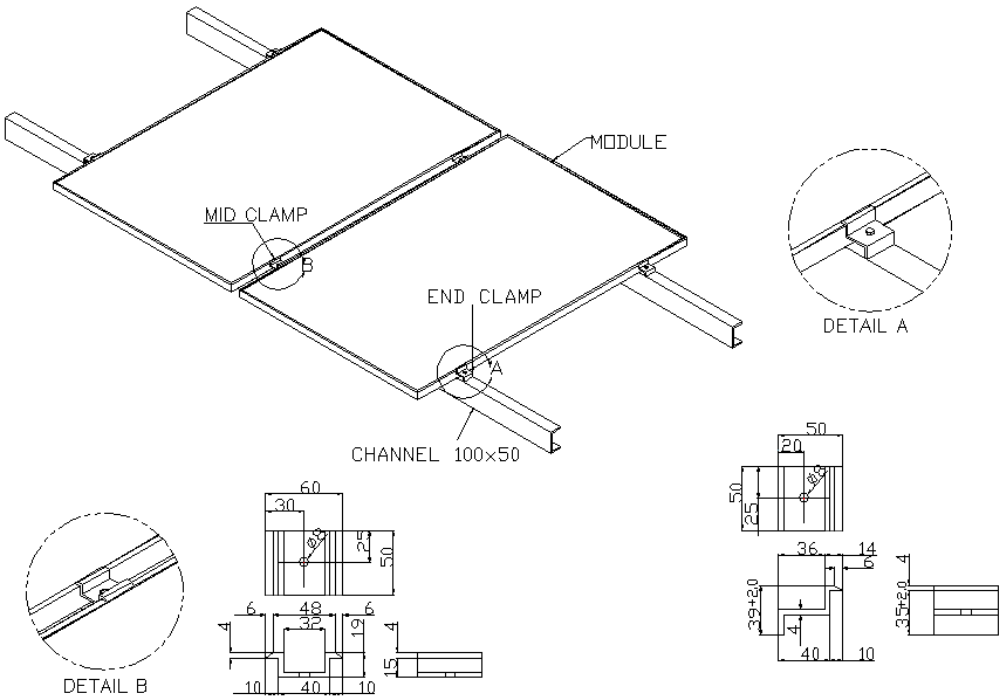
Picture 2. HiS-MxxxMG Hole Position



Picture 3. Installation Method using bolt & nut



Picture 4. Mounting Hardware



Picture 5. Installation Method using clamping

4. Specifications

4.1 Notes on Specification

· Nominal Electrical Characteristics : Within 4% under STC condition

· Standard Test Condition (STC): Irradiation 1,000 W/㎡, Cell Temperature 25 ℃, 1.5 AM

· Electrical Characteristics : HiS-MxxxMF(Multi-Crystalline Si Type, 3 Bus Bar Type, 54 Cells)

Item	HiS-MxxxMF (xxx;Normal Power Value)						
Normal Power (Pmax)	200	203	205	208	210	213	215
Voltage at Pmax (Vmpp)	26.9	27.1	27.1	27.1	27.3	27.4	27.6
Current at Pmax (Impp)	7.5	7.5	7.6	7.7	7.7	7.8	7.8
Open circuit voltage (Voc)	32.8	33.0	33.1	33.2	33.3	33.5	33.6
Short circuit current (Isc)	8.0	8.1	8.1	8.2	8.2	8.3	8.3
Module efficiency	13.8	14.0	14.1	14.3	14.5	14.7	14.8
Temp. coefficient of Pmpp [%/K]	-0.43						
Temp. coefficient of Voc [%/K]	-0.32						
Temp. coefficient of Isc [%/K]	0.056						
Output tolerance [%]	+3/-0						
Maximum system voltage [Vdc]	1,000						
Cell quantity in series [pcs]	54						
Bypass diodes [pcs]	3						
Cell Type	6inches, Multi-crystalline Silicon Cell						
Safety Qualification & Class	IEC 61215 & Class II						
Maximum Series Fuse Rating [A]	15						
Fire Class rating	Class C						

· Electrical Characteristics : HiS-SxxxMF(Mono-Crystalline Si Type, 3 Bus Bar Type, 54 Cells)

Item	HiS-SxxxMF (xxx;Normal Power Value)						
Normal Power (Pmax)	213	215	218	220	223	225	228
Voltage at Pmax (Vmpp)	27.0	27.3	27.6	27.6	27.6	27.8	27.9
Current at Pmax (Impp)	7.9	7.9	7.9	8.0	8.1	8.1	8.2
Open circuit voltage (Voc)	33.4	33.5	33.6	33.6	33.7	33.7	33.8
Short circuit current (Isc)	8.4	8.4	8.4	8.5	8.5	8.6	8.7
Module efficiency	14.7	14.8	15.0	15.2	15.4	15.5	15.7
Temp. coefficient of Pmpp [%/K]	-0.44						
Temp. coefficient of Voc [%/K]	-0.34						
Temp. coefficient of Isc [%/K]	0.052						
Output tolerance [%]	+3/-0						
Maximum system voltage [Vdc]	1,000						
Cell quantity in series [pcs]	54						
Bypass diodes [pcs]	3						
Cell Type	6inches, Mono-crystalline Silicon Cell						
Safety Qualification & Class	IEC 61215 & Class II						
Maximum Series Fuse Rating [A]	15						
Fire Class rating	Class C						

· Electrical Characteristics : HiS-MxxxMG(Multi-Crystalline Si Type, 3 Bus Bar Type, 60 Cells)

Item	HiS-MxxxMG (xxx;Normal Power Value)						
Normal Power (Pmax)	223	225	228	230	233	235	238
Voltage at Pmax (Vmpp)	30.0	30.0	30.0	30.1	30.3	30.3	30.4
Current at Pmax (Impp)	7.4	7.5	7.6	7.7	7.7	7.8	7.8
Open circuit voltage (Voc)	36.8	37.1	37.1	37.1	37.3	37.4	37.4
Short circuit current (Isc)	8.0	8.2	8.2	8.2	8.2	8.3	8.3
Module efficiency	13.8	13.9	14.1	14.2	14.4	14.5	14.7
Temp. coefficient of Pmpp [%/K]	-0.43						
Temp. coefficient of Voc [%/K]	-0.32						
Temp. coefficient of Isc [%/K]	0.056						
Output tolerance [%]	+3/-0						
Maximum system voltage [Vdc]	1,000						
Cell quantity in series [pcs]	60						
Bypass diodes [pcs]	3						
Cell Type	6inches, Multi-crystalline Silicon Cell						
Safety Qualification & Class	IEC 61215 & Class II						
Maximum Series Fuse Rating [A]	15						
Fire Class rating	Class C						

· Electrical Characteristics : HiS-SxxxMG(Mono-Crystalline Si Type, 3 Bus Bar Type, 60 Cells)

Item	HiS-SxxxMG (xxx;Normal Power Value)						
Normal Power (Pmax)	235	238	240	243	245	248	250
Voltage at Pmax (Vmpp)	29.8	29.8	30.1	30.1	30.3	30.3	30.5
Current at Pmax (Impp)	7.9	8.0	8.0	8.1	8.1	8.2	8.2
Open circuit voltage (Voc)	37.0	37.0	37.3	37.3	37.4	37.5	37.5
Short circuit current (Isc)	8.4	8.5	8.5	8.6	8.6	8.7	8.7
Module efficiency	14.5	14.7	14.8	15.0	15.2	15.3	15.5
Temp. coefficient of Pmpp [%/K]	-0.44						
Temp. coefficient of Voc [%/K]	-0.34						
Temp. coefficient of Isc [%/K]	0.052						
Output tolerance [%]	+3/-0						
Maximum system voltage [Vdc]	1,000						
Cell quantity in series [pcs]	60						
Bypass diodes [pcs]	3						
Cell Type	6inches, Mono-crystalline Silicon Cell						
Safety Qualification & Class	IEC 61215 & Class II						
Maximum Series Fuse Rating [A]	15						
Fire Class rating	Class C						

· Mechanical Characteristics (HiS-MxxxMF/HiS-SxxxMF)

Description	HiS-MxxxMF/HiS-SxxxMF
Length, mm(inches)	1,476 (58.1)
Width, mm(inches)	983 (38.7)
Depth, mm(inches)	35 (1.38)
Weight, kg(pounds)	17.0 (37.5)

· Mechanical Characteristics (HiS-MxxxMG/HiS-SxxxMG)

Description	HiS-MxxxMG/HiS-SxxxMG
Length, mm(inches)	1,645(64.7)
Width, mm(inches)	983(38.7)
Depth, mm(inches)	35 (1.38)
Weight, kg(pounds)	19.0(41.9)

· The specifications in the datasheet is tested under STC conditions.

· In ambient condition, PV modules may have higher levels of voltage and current comparing with the data in STC conditions. Therefore, all electrical characteristics such as Isc, Voc must be considered 25% more at the design stage for the nominal voltage, the conduction capacity, the fuse size, the controller capacity, etc.

Ambient Temperature		Correction Factor
Celsius (℃)	Fahrenheit (℉)	
25 ~ 10	77 ~ 50	1.06
9 ~ 0	49 ~ 32	1.10
-1 ~ -10	31 ~ 14	1.14
-11 ~ -20	13 ~ -4	1.18
-21 ~ -40	-5 ~ -40	1.25

4.2 Mechanical Loading

As the picture1, picture2 shows, a PV module has 2 mounting holes and 2 NOT USED HOLE at each side, a total of 8 holes. Please select outside mounting holes at each side. This can resist nominal load on the module surface of 5,400 Pa (5,400N/m2, 550kg/m2, 112 lb/ft2) at maximum.

5. Wiring

5.1 General

· All wiring should be matched with proper electrical codes, NEC (USA) or CEC (Canada).

· All wiring work should be done by a certified and authorized engineer.

· All wiring should be connected safely in order to prevent any hazard.

· All PV modules for one serial connection must be identical in terms of output, in types and manufacturer of solar cells.

· Do not connect PV modules directly in parallel without the junction box.

5.2 Module Wiring

· Maximum system voltage should not exceed 1000[V].

· The maximum number of modules in parallel connection depends on inverter's capacity.

· PV modules are not designed to be connected to load directly. Therefore, a proper inverter must be connected.

· Bypass diodes are installed on the modules at the factory. Wrong connection may cause damage to the bypass diodes, cable and junction box.

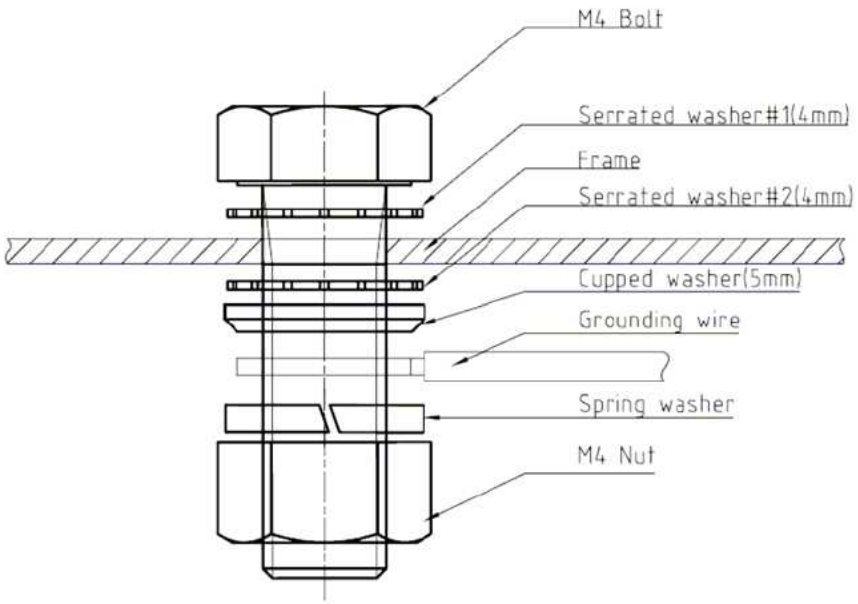
· Fuse rating : Use 15A max series fuse. Fuse capacitance is calculated by using Isc×1.56.

5.3 Array Wiring

'Array' is defined as a module arrangement with combined electrical connection. The array must be insulated to resist against the possible maximum open-circuit voltage. Also, solar irradiation-proof copper wires must be used for array wiring. Installers must check the local electrical specifications. In order to prevent cable drooping, installers should fix cable using wire or duct.

5.4 Earth Ground Wiring

To prevent electric shock and fire, an earthing must be done on the frames of PV modules and array. The array frame must be earthed according to NEC Article 250 (USA) or CEC (Canada). There is an earthing hole in the module frame; by using these holes, an earth conductor and the module frame must be connected and earthed. (See picture 6)

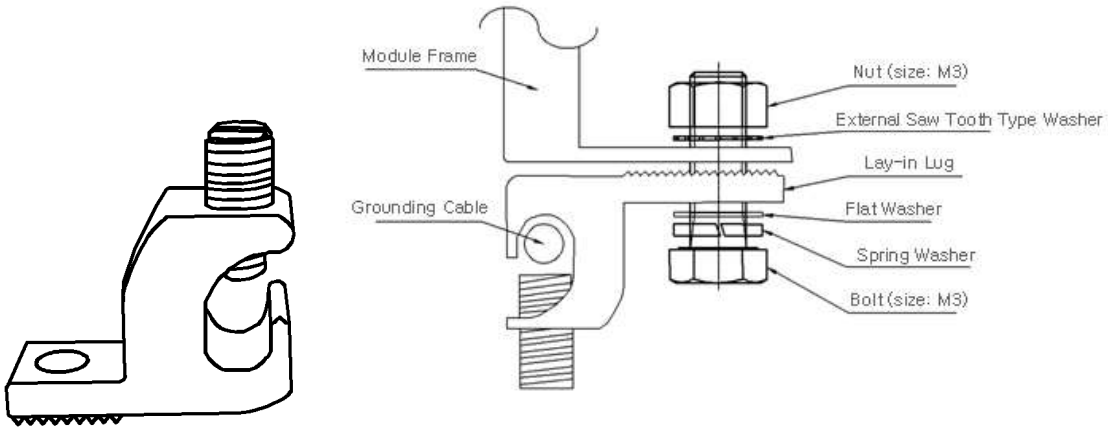


Picture 6. Grounding Hardware

1) Grounding using Lay-in Lug

It is necessary to ground module at earth hole (4.2mm / all frame) using GBL-4DBT Lay-in lug of ILSCO or a product certified of quality above. In order to connect module frame and Lay-in-lug electric more effectively, installers should use external saw tooth type washer or saw tooth type Lug and torque wrench(Torque level: 1.5 N·M).

The material for bolt, nut, washer and lug should be stainless steel.



Picture 7. Lay in Ground Lug

5.5 Module Terminations

The installer should connect cables using the same cable connector equipped in Each PV module. For more information about electrical connection, contact an authorized engineer of HHI.

5.6 Junction Box & Terminals

A PV module has the plus and minus connectors and a junction box with bypass diodes. On the junction box, the polarity is clearly marked(See the picture 12).

1) Protection Degree : IP65
2) Temperature Range : -40°C ~ +85°C
3) Wire Size : 4.0mm^2 (AWG 12)
4) The cable must not be bent or crushed on the direct exit of the cable screw joint. A minimum bending radius R≥5 x cable diameter must be maintained. The cable must be routed in a way that tensile stress on the conductor or connections is prevented

5.7 Conduit

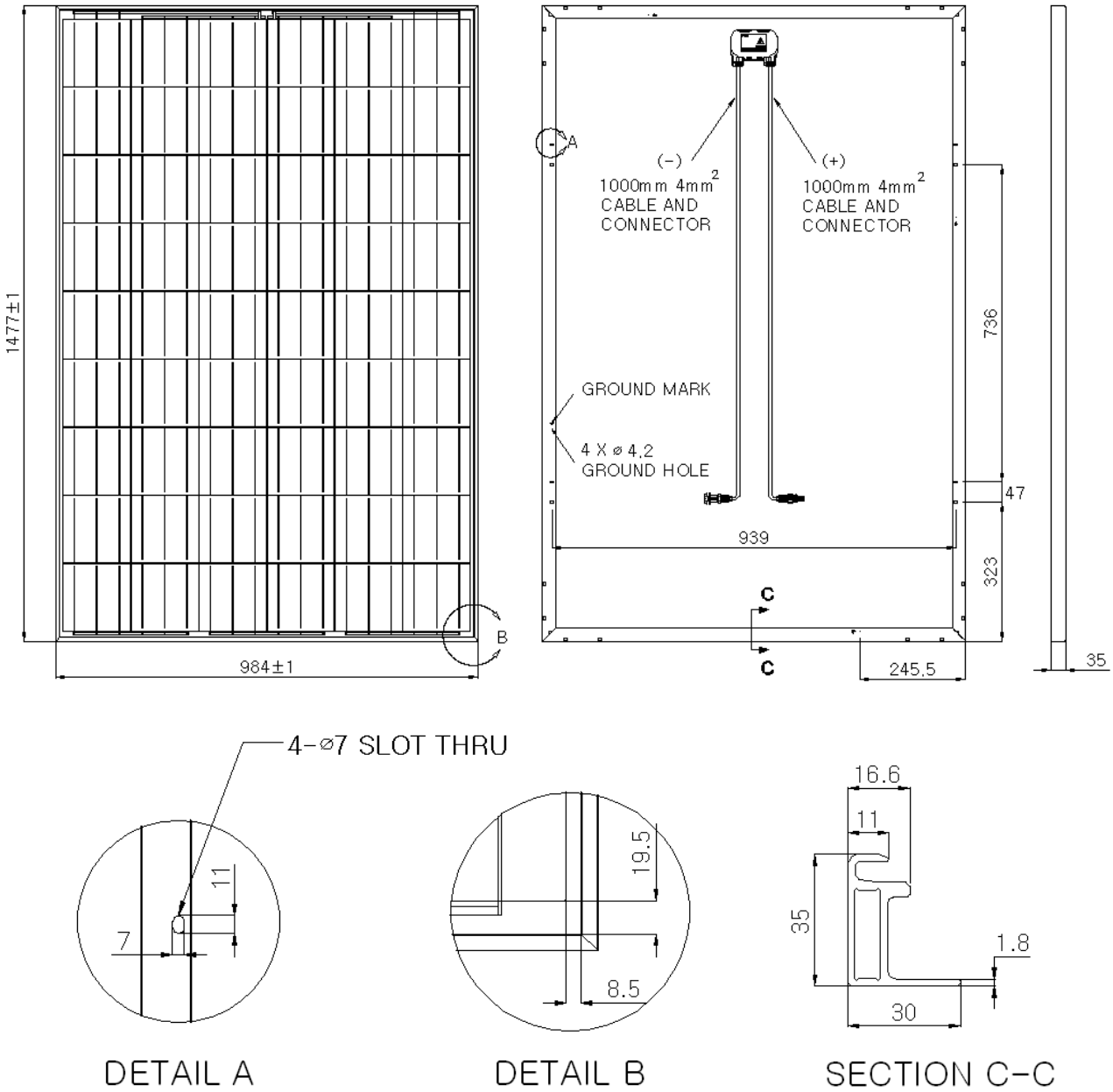
For conduit application, it is necessary to follow the regulation for outdoor installation of conduit. All fixing parts should be protected from any damage and moisture.

6. Diodes

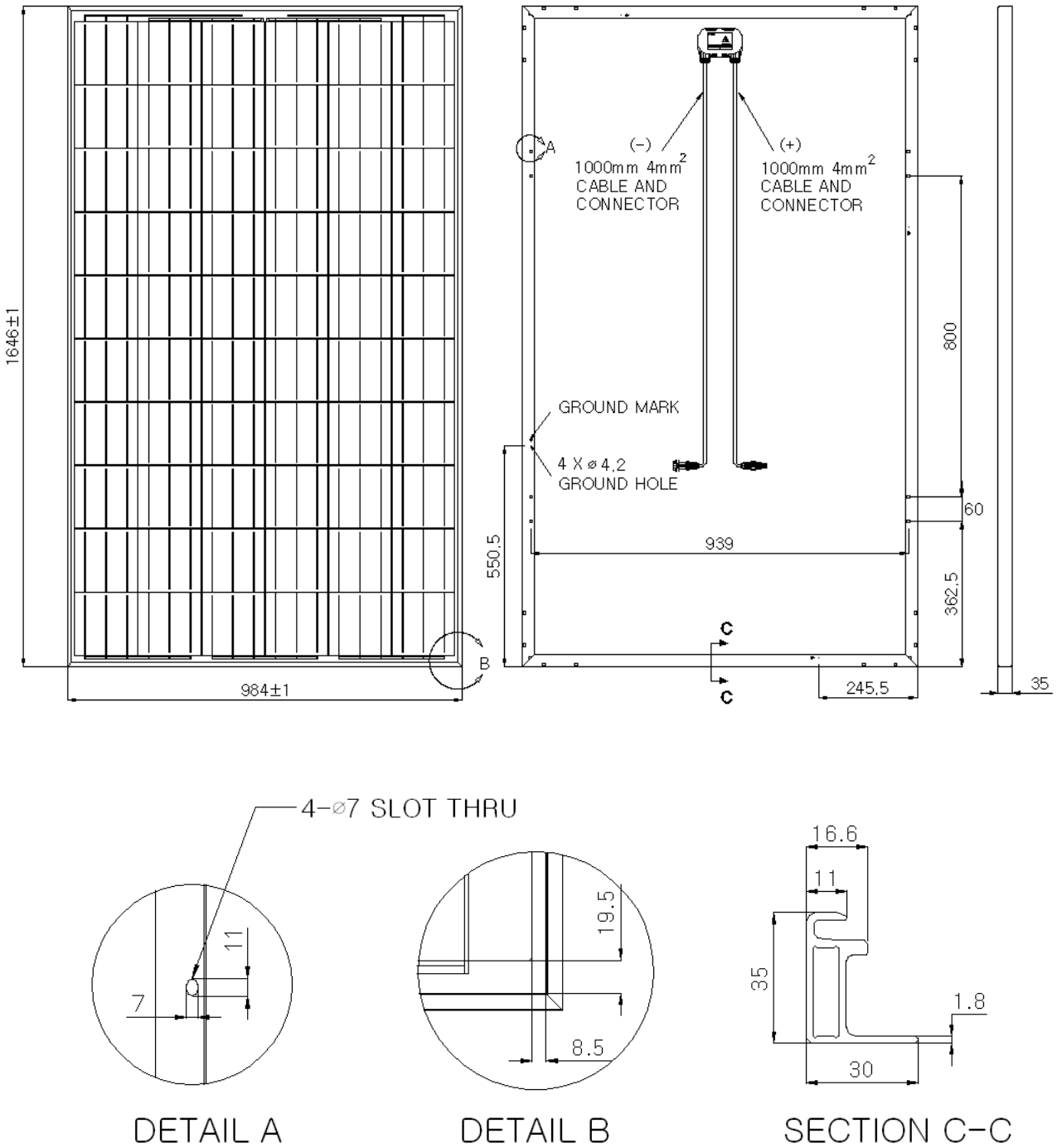
When there is partial shade on a PV module, reverse-voltage can circulate inside PV module. In order to protect this phenomenon, the diodes are normally installed in a Junction Box. HHI PV modules are equipped with bypass diodes. If installer wishes to apply additional diode, he or she should inform an authorized engineer of HHI.

7. Maintenance

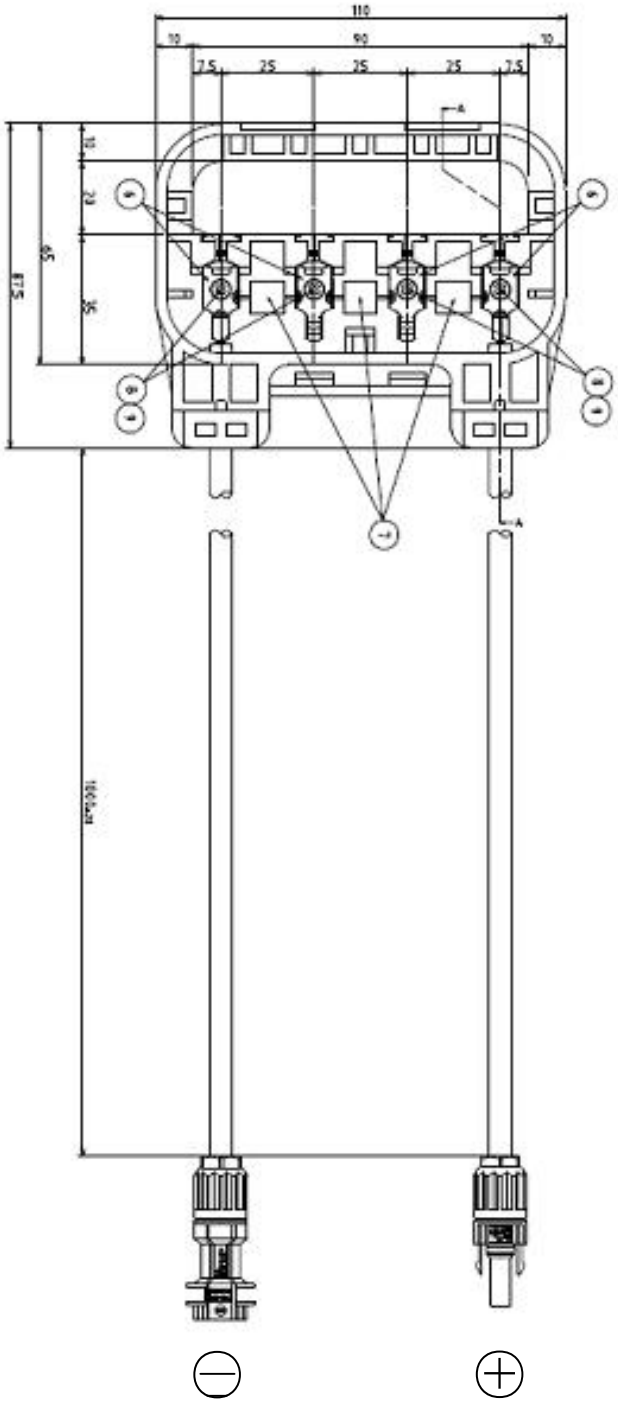
MF, MG series modules are designed for long life and require very little maintenance. Under most weather conditions, normal rainfall is sufficient to keep the module glass surface clean. If dirt build-up becomes excessive, clean the glass surface only with a soft cloth using mild detergent and water. PV modules that are mounted flat should be cleaned more offen, as they will not “self clean” as effectively as modules mounted at a 15° tilt or greater.



Picture 10. Standard module Layout & Ground position (HiS-MxxxMF)



Picture 11. Standard module Layout & Ground position (HiS-MxxxMG)



Picture 12. Junction box

APPENDIX 1. Module Installation Instruction(HIS-MxxxMF, HIS-MxxxMG, HIS-SxxxMF, HIS-SxxxMG)

1) Horizontal (Crosswise) Direction

<table>
<tr><th colspan="2">Method</th><th>2400 Pa</th><th>5400 Pa</th></tr>
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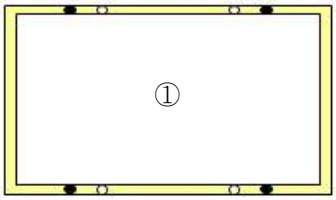
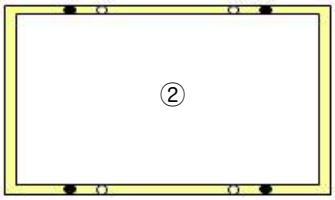
● : Mounting hole
O : Not used hole
(For other purpose)</td><td>Long Bar</td><td> 
</td><td> 
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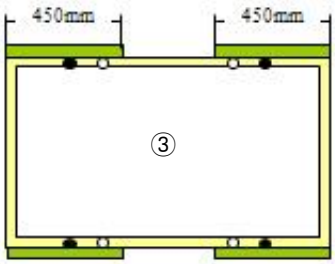
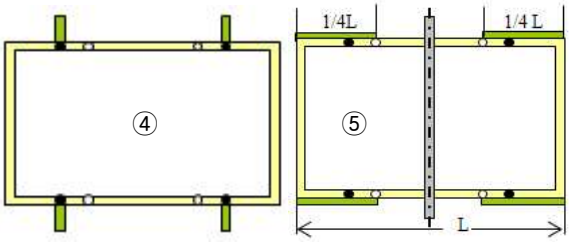
● : Mounting hole
O : Not used hole
(For other purpose)
■ : Clamping area
▨ : Additional support bar area</td><td>Long Bar</td><td> 
</td><td> 
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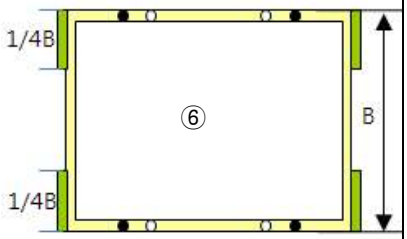
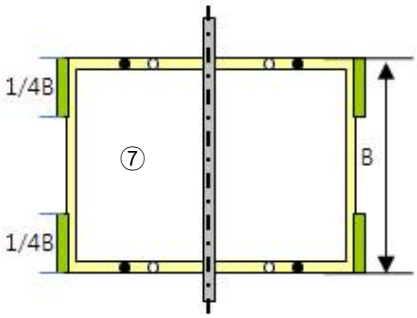
<tr><td>Short Bar</td><td> 
</td><td> 
</td></tr>
</table>

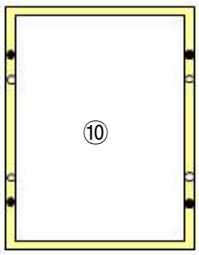
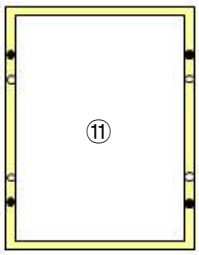
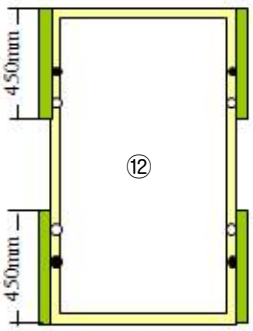
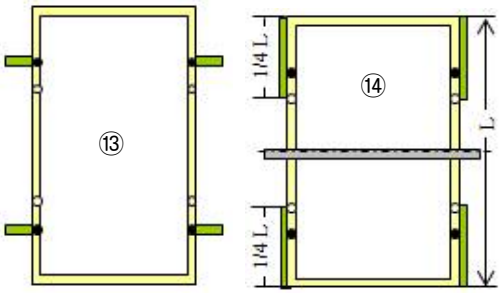
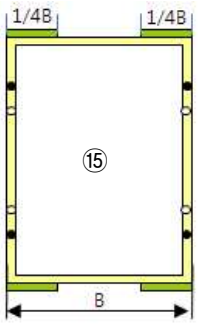
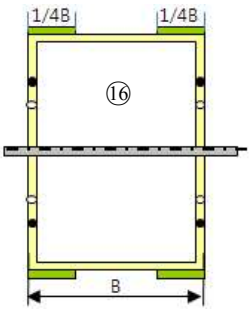
Note 1) Additional support should be applied in order to prevent any damage from heavy snow. (⑤,⑦)

2) It is recommended to fix module by the additional supporting parts and supplement clamps on the middle of long bar at the lowest module if installed in heavy snow area. (⑥)

3) This module passes 2,400Pa and 5,400Pa mechanical load tests based on IEC61215 ed.2. The installation methods which are described in HYUNDAI HEAVY INDUSTRIES INSTALLATION MANUAL are covered by 2,400Pa warranty (The certified mounting method is bolting method with 2,400 Pa & 5,400 Pa by TÜV Rheinland).

4) Prior to applying other methods of installation not included in this Installation Manual, additional Mechanical Load Test must be carried out and confirmed beforehand.

2) Vertical (Lengthwise) Direction

Method		2400 Pa	5400 Pa
Bolting ● : Mounting hole O : Not used hole (For other purpose)	Long Bar		
Clamping ● : Mounting hole O : Not used hole (For other purpose) : Clamping area : Additional support bar area	Long Bar		
	Short Bar		

Note 1) Additional support should be applied in order to prevent any damage from heavy snow. (⑭,⑯).

2) It is recommended to fix module by the additional supporting parts and supplement clamps on the middle of short bar at the lowest module if installed in heavy snow area (⑩,⑪,⑫,⑬,⑭)

3) This module passes 2,400Pa and 5,400Pa mechanical load tests based on IEC61215 ed.2. The installation methods which are described in HYUNDAI HEAVY INDUSTRIES INSTALLATION MANUAL are covered by 2,400Pa warranty (The certified mounting method is bolting method with 2,400 Pa & 5,400 Pa by TÜV Rheinland).

4) Prior to applying other methods of installation not included in this Installation Manual, additional Mechanical Load Test must be carried out and confirmed beforehand.